

## SENIOR HIGH LABORATORY-BASED NATURAL SCIENCE CURRICULUM

### Two-Year Sequence

The goal of this curriculum is to increase the number of students meeting state science standards at the high school level. This can be done through this rigorous two-year course of study in natural sciences for grades 9-10, which is aligned with state science standards and meets the entrance requirements of post-secondary institutions.

Each of the units listed in the table of contents has two parts. The first part is a listing of the Nebraska Science Standards covered by that unit. The second part contains a suggested sequence of instruction, which outlines the skills and concepts to be taught. Numbers in parentheses reference the Nebraska Twelfth-Grade Science Standards.

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**YEAR ONE**

**SENIOR HIGH**

**LABORATORY-BASED**

**NATURAL SCIENCE COURSE**

**Table of Contents for Year One**

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# SENIOR HIGH LABORATORY-BASED NATURAL SCIENCE CURRICULUM YEAR ONE

SECTION I	INQUIRY	YEAR 1
Standards and Example Indicators		
12.1.2	<b>Evidence, models, and explanation</b> <ul style="list-style-type: none"><li>a. Create a physical, mental, or mathematical model to show how objects and processes are connected.</li><li>b. Test the usefulness of the model by comparing its predictions to actual observations.</li><li>c. Understand that the way data are displayed affects interpretation.</li><li>d. Evaluate the reasonableness of answers to problems.</li><li>e. Understand that larger well-chosen samples produce more accurate estimates of the characteristics of the total population.</li><li>f. Understand that a correlation between two variables does not mean that either one causes the other.</li></ul>	
12.1.3	<b>Change, constancy, and measurement</b> <ul style="list-style-type: none"><li>a. Uses of powers of ten to represent large and small numbers.</li><li>b. Compare data for two groups by using averages and ranges of values.</li><li>c. Understand that measurement errors may affect results of calculations.</li><li>d. Describe rate of change by comparing one measured quantity to another measured quantity.</li><li>e. Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease.</li></ul>	
12.2.1	<b>Basic Inquiry</b> <ul style="list-style-type: none"><li>a. Formulate questions and identify concepts that guide scientific investigations.</li><li>b. Design and conduct scientific investigations.</li><li>c. Use technology and mathematics to improve investigations and communications.</li><li>d. Formulate and revise scientific explanations and models using logic and evidence.</li><li>e. Recognize and analyze alternative explanations and models.</li><li>f. Communicate and defend a scientific argument.</li></ul>	
12.8.1	<b>Science as a human endeavor</b> <ul style="list-style-type: none"><li>a. Recognize Science as one way of answering questions and explaining the natural world.</li></ul>	
12.8.2	<b>Nature of Scientific Knowledge</b> <ul style="list-style-type: none"><li>a. Create scientific explanations consistent with experimental and observational evidence; make accurate predictions; strive to be logical; respect the rules of evidence; accept criticism; report methods and procedures; and make knowledge public.</li></ul>	
Concepts and Skills within Standards		
<b>Features of Inquiry (12.2.1)</b> <ul style="list-style-type: none"><li>• Formulate questions and identify concepts that guide scientific investigations.</li><li>• Design and conduct scientific investigations.</li><li>• Use technology and mathematics to improve investigations and communications.</li><li>• Formulate and revise scientific explanations and models using logic and evidence.</li><li>• Recognize and analyze alternative explanations and models.</li><li>• Communicate and defend a scientific argument.</li><li>• Recognize Science as one way of answering questions and explaining the natural world (12.8.1)</li><li>• Create scientific explanations consistent with experimental and observational evidence; make accurate predictions; strive to be logical; respect the rules of evidence; accept criticism; report methods and procedures; and make knowledge public. (12.8.2)</li></ul>		

**Concepts and Skills within Standards**

1. Engaging in Scientifically Oriented Questions
  - a. Formulate questions and identify concepts that guide scientific investigations. (12.2.1)
    - i. Questioning
    - ii. Predicting
    - iii. Forming Hypotheses
2. Responding to Questions using Evidence
  - a. Design and conduct scientific investigations. (12.2.1)
    - i. Identifying Variables
  - b. Designing Experiments
    - i. Understand that larger well-chosen samples produce more accurate estimates of the characteristics of the total population. (12.1.2)
  - c. Making Qualitative and Quantitative Observations
    - i. Understand that measurement errors may affect results of calculations. (12.1.3)
  - d. Recording Data
3. Formulating Explanations from Evidence
  - a. Use technology and mathematics to improve investigations and communications.
    - i. Organizing Data
      - 1) Understand that the way data are displayed affects interpretation. (12.1.2)
        - a) Graphs
        - b) Tables
        - c) Calculations
      - i) Uses of powers of ten to represent large and small numbers. (12.1.3)
    - d) Schematics
    - ii. Manipulating Data
    - iii. Interpreting Evidence
      - 1) Evaluate the reasonableness of answers to problems. (12.1.2)
      - 2) Understand that a correlation between two variables does not mean that either one causes the other. (12.1.2)
      - 3) Compare data for two groups by using averages and ranges of values. (12.1.3)
      - 4) Describe rate of change by comparing one measured quantity to another measured quantity. (12.1.3)
      - 5) Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease. (12.1.3)
    - iv. Creating Models
      - 1) Create a physical, mental, or mathematical model to show how objects and processes are connected (12.1.2)
4. Connecting Explanations to Scientific Knowledge
  - a. Formulate and revise scientific explanations and models using logic and evidence.
    - i. Inferring
    - ii. Connecting to Existing Models
      - 1) Test the usefulness of the model by comparing its predictions to actual observations. (12.1.2)
    - iii. Defending Findings
      - 1) Evaluate the reasonableness of answers to problems. (12.1.2)
5. Communicating and Justifying Explanations
  - a. Recognize and analyze alternative explanations and models.
  - b. Communicate and defend a scientific argument.
    - i. Communicating Explanations
    - ii. Defending Explanations
    - iii. Publishing
    - iv. Determining Applications
    - v. Asking Further Questions

**Standards and Example Indicators****12.1.2 Evidence, Models, and Explanations**

- a. Test the usefulness of a model by comparing its predictions to actual observations.
- b. Evaluate the reasonableness of answers to problems.

**12.2.1 Science as Inquiry**

- a. Formulate questions and identify concepts that guide scientific investigations.

**12.3.1 The Atom**

- a. Investigate and explain the type of nuclear reactions.

**12.5.4 Origin of the Universe**

- a. Describe and analyze the Big Bang theory on the origin of the universe.
- b. Describe various types of galaxies including spherical, elliptical, and irregular.
- c. Describe the life cycle of a star.

**Concepts and Skills within Standards**

1. Questions about Origins of the Universe
  - a. Formulate questions and identify concepts that guide scientific investigations. (12.2.1)
2. Big Bang
  - a. Theory of Big Bang
  - b. Evidence for expanding universe
    - i. Test the usefulness of a model by comparing its predictions to actual observations. (12.1.2)
    - ii. Evaluate the reasonableness of answers to problems. (12.1.2)
3. Galaxy Formation
  - a. Types of Galaxies
    - i. spherical
    - ii. elliptical
    - iii. irregular
    - iv. spiral
  - b. The Milky Way Galaxy
4. Birth and Death of Stars
  - a. Life Cycle of a Star
    - i. Formation
    - ii. Main Sequence
    - iii. Possible Death
  - b. Fusion
    - i. Investigate and explain the type of nuclear reactions. (12.3.1)

**Standards and Example Indicators****12.1.2 Evidence, Models, and Explanation**

- a. Test the usefulness of a model by comparing its predictions to actual observations.

**12.1.3 Change, Constancy, and Measurement**

- a. Describe rate of change by comparing one measured quantity to another measured quantity.

**12.2.1 Scientific Inquiry**

- a. Formulate and revise scientific explanations and models using logic and evidence.
- b. Recognize and analyze alternative explanations and models.

**12.3.1 The Atom**

- a. Investigate and describe the structure of atoms, focusing on properties of subatomic particles.
- b. Investigate and explain the types of nuclear reactions.
- c. Investigate and describe the effect of electrical and nuclear forces which hold atoms together.

**12.5.3 Origin of the Earth System**

- a. Predict when rocks were formed by using known decay rates of radioactive isotopes in rocks.

**12.8.2 Nature of Scientific Knowledge**

- a. Demonstrate the use of empirical standards, logical arguments, and skepticism in science.
- b. Understand that all scientific knowledge is, in principle, subject to change as new evidence becomes available.

**12.8.3 Historical Contributors**

- a. Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions.
- b. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge.
- c. Understand that some advancements in science and technology have long-lasting effects on society.

**Concepts and Skills within Standards**

1. Historical Models
  - a. Test the usefulness of a model by comparing its predictions to actual observations. (12.1.2)
  - b. Formulate and revise scientific explanations and models using logic and evidence. (12.2.1)
  - c. Recognize and analyze alternative explanations and models. (12.2.1)
  - d. Demonstrate the use of empirical standards, logical arguments, and skepticism in science. (12.8.2)
  - e. Understand that all scientific knowledge is, in principle, subject to change as new evidence becomes available. (12.8.2)
  - f. Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions. (12.8.3)
  - g. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge. (12.8.3)
  - h. Understand that some advancements in science and technology have long-lasting effects on society. (12.8.3)
    - i. Bohr Model of the atom
    - ii. Rutherford
    - iii. Properties of proton
    - iv. Thompson/plum pudding
    - v. Crooke/Cathode rays
    - vi. Milliken oil drop
2. Parts and Properties of Atom
  - a. Electron
  - b. Nucleus
    - i. Proton
    - ii. Neutron
3. Structure of Atoms
  - a. Electrical forces
  - b. Nuclear forces
4. Isotopes and Radioactive Decay
  - a. Isotopes
  - b. Radioactive decay
    - i. Predict when rocks were formed by using known decay rates of radioactive isotopes in rocks. (12.5.3)
    - ii. Describe rate of change by comparing one measured quantity to another measured quantity. (12.1.3)
  - c. Historical perspectives (M. Curie)
    - i. Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions. (12.8.3)
    - ii. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge. (12.8.3)
    - iii. Understand that some advancements in science and technology have long-lasting effects on society. (12.8.3)

**Standards and Example Indicators****12.1.2 Evidence, Models, and Explanation**

- a. Test the usefulness of a model by comparing its predictions to actual observations.
- b. Create a physical, mental, or mathematical model to show how objects and processes are connected.

**12.1.3 Change, Constancy, and Measurement**

- a. Use powers of ten to represent large and small numbers.

**12.3.2 Structure and Properties of Matter**

- a. Investigate and understand that atoms interact with one another by transferring or sharing electron.
- b. Investigate and explain the periodic table of elements in terms of repeating patterns of physical and chemical properties.
- c. Investigate and describe how the structure of an atom determines the chemical properties of an element.
- d. Investigate and describe how the interactions among the molecules of a compound determine its physical and chemical properties.
- e. Investigate and use changes in energy to explain the differences among the states of matter.
- f. Investigate and describe the bonding of carbon atoms in chains and rings to produce compounds essential to life.

**12.3.3 Understanding of Chemical reactions**

- a. Investigate and describe common chemical reactions.
- b. Investigate and describe the change of energy as a result of chemical reactions.
- c. Investigate and describe how electrons are involved in bond formation during chemical reactions.
- d. Investigate and describe the factors influencing the rates of chemical reactions including catalysts.

**12.3.4 Motion and Forces**

- a. Investigate and understand electrical force as a force that exists between any two charged objects.

**12.3.6 Interactions of energy and matter**

- a. Investigate and describe how the composition and temperature of a material affect electron flow.



<b>Concepts and Skills with Standards</b>
<b>A. Structure and Properties of Matter (12.3.2)</b>
<ol style="list-style-type: none"> <li>1. Periodic Table               <ol style="list-style-type: none"> <li>a. Investigate properties of some elements</li> <li>b. Examine patterns in the periodic table</li> <li>c. Valence electrons</li> <li>d. Properties of metals versus nonmetals                   <ol style="list-style-type: none"> <li>i. Investigate and describe how the composition and temperature of a material affect electron flow. (12.3.6)</li> </ol> </li> </ol> </li> <li>2. Form and function of the periodic table as it relates to properties               <ol style="list-style-type: none"> <li>a. Test the usefulness of a model by comparing its predictions to actual observations. (12.1.2)</li> <li>b. Create a physical, mental, or mathematical model to show how objects and processes are connected. (12.1.2)</li> </ol> </li> <li>3. States of Matter</li> <li>4. Transferring and sharing of electrons               <ol style="list-style-type: none"> <li>a. Investigate and understand electrical force as a force that exists between any two charged objects. (12.3.4)                   <ol style="list-style-type: none"> <li>i. Ionic Bonding</li> <li>ii. Covalent Bonding</li> <li>iii. Hydrogen Bonding</li> <li>iv. Carbon Rings and Chains</li> </ol> </li> </ol> </li> </ol>
<b>B. Understanding of Chemical reactions (12.3.3)</b>
<ol style="list-style-type: none"> <li>1. Types of chemical reactions               <ol style="list-style-type: none"> <li>a. Synthesis</li> <li>b. Decomposition</li> </ol> </li> <li>2. Balancing equations</li> <li>3. Endothermic versus exothermic reactions</li> <li>4. Factors influencing chemical rates.               <ol style="list-style-type: none"> <li>a. Catalysts,</li> <li>b. Temperature,</li> <li>c. Surface Area</li> <li>d. Concentration                   <ol style="list-style-type: none"> <li>i. Use powers of ten to represent large and small numbers. (12.1.3)</li> </ol> </li> </ol> </li> </ol>

**Standards and Example Indicators****12.1.1 Systems, Order, and Organization**

- a. Predict and evaluate how change within a system affects that system.
- b. Design solutions to problems identified within a system.

**12.1. Evidence, Models, and Explanations**

- a. Create a physical, mental, or mathematical model to show how objects and processes are connected.

**12.1.4 Form and Function**

- a. Explain function by referring to form and explain form by referring to function.

**12.1.5 Change Over Time**

- a. Explain how a system at equilibrium is affected by change.

**12.2.1 Scientific Inquiry**

- a. Design and conduct scientific investigations.
- b. Communicate and defend a scientific argument.

**12.4.1 Cell**

- a. Investigate and describe the form and function of subcellular structures that regulate cell-activities.
- b. Investigate and describe cell functions (e.g., photosynthesis, respiration, cell division).
- c. Investigate and understand that complex multicellular organisms are formed as highly organized arrangements of differentiated cells.

**12.4.5 Organization in Living Systems**

- a. Investigate and understand that living systems require a constant input of energy to maintain their chemical and physical organization.
- b. Investigate and understand that producers use solar energy to combine molecules of carbon dioxide and water into organic compounds.

**12.4.6 Respond to External and Internal Stimuli**

- a. Investigate and describe how nervous systems function in multicellular animals.
- b. Investigate and describe how organisms respond to internal changes and external stimuli.

**12.6.2 Interactions of Science & Technology**

- a. Explain how science advances with the introduction of new technology.

**12.7.6 Role of Science and Technology in Local, National, and Global Challenges**

- a. Understand that knowledge of basic concepts about scientific and technological challenges should proceed active debate.
- b. Investigate and understand that social issues and challenges may affect advancements in science and technology.
- c. Understand that science and technology are essential social enterprises that indicate what could happen, but not what should happen.

**12.8.1 Science as a Human Endeavor**

- a. Demonstrate ethical scientific practices (e.g., informing research subjects about risks and benefits, human treatment of animals, truthful reporting, public disclosure of work, and peer review).
- b. Examine and understand the societal, cultural, and personal beliefs that influence scientists.

**12.8.3 Historical Contributors (e.g. Schwann, Scheiden, & VanLeeuwenhoek)**

- a. Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions.
- b. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge.
- c. Understand that some advancements in science and technology have long-lasting effects on society.

<b>Concepts and Skills with Standards</b>
<b>A. Cell Organelles: Structure and Function</b>
<ol style="list-style-type: none"> <li>1. Structure of a Cell               <ol style="list-style-type: none"> <li>a. Create a physical, mental, or mathematical model to show how objects and processes are connected. (12.1.2)</li> <li>b. Explain function by referring to form and explain form by referring to function. (12.1.4)                   <ol style="list-style-type: none"> <li>i. Cell membrane</li> <li>ii. Cytoplasm</li> <li>iii. Organelles                       <ol style="list-style-type: none"> <li>1) Nucleus</li> <li>2) Mitochondria</li> <li>3) Ribosomes</li> <li>4) Endoplasmic Reticulum</li> <li>5) Vacuole</li> <li>6) Golgi Apparatus</li> <li>7) Lysosome</li> <li>8) Chloroplast</li> </ol> </li> </ol> </li> </ol> </li> <li>2. Compare and Contrast Plant &amp; Animal Cells</li> </ol>
<b>B. Bioprocesses</b>
<ol style="list-style-type: none"> <li>1. Transport               <ol style="list-style-type: none"> <li>a. Passive</li> <li>b. Active</li> </ol> </li> <li>2. Photosynthesis               <ol style="list-style-type: none"> <li>a. Design solutions to problems identified within a system (12.1.1)</li> <li>b. Investigate and understand that living systems require a constant input of energy to maintain their chemical and physical organization. (12.4.5)</li> <li>c. Investigate and understand that producers use solar energy to combine molecules of carbon dioxide and water into organic compounds. (12.4.5)                   <ol style="list-style-type: none"> <li>i. Formula of reaction</li> <li>ii. Structures involved</li> </ol> </li> </ol> </li> <li>3. Respiration               <ol style="list-style-type: none"> <li>a. Investigate and understand that living systems require a constant input of energy to maintain their chemical and physical organization. (12.4.5)</li> </ol> </li> <li>4. Cell Division, Mitosis</li> </ol>
<b>C. Cellular Responses</b>
<ol style="list-style-type: none"> <li>1. Predict and evaluate how change within a system affects that system. (12.1.1)</li> <li>2. Explain how a system at equilibrium is affected by change. (12.1.5)</li> <li>3. Single Celled Organisms               <ol style="list-style-type: none"> <li>a. Investigate and describe how organisms respond to internal changes and external stimuli. (12.4.6)</li> </ol> </li> <li>4. Multicellular Organism               <ol style="list-style-type: none"> <li>a. Organization</li> <li>b. Responses                   <ol style="list-style-type: none"> <li>i. Investigate and describe how nervous systems function in multicellular animals.</li> <li>ii. Investigate and describe how organisms respond to internal changes and external stimuli. (12.4.6)</li> </ol> </li> </ol> </li> </ol>

Concepts and Skills within Standards
D. Historical and Current Issues
<ol style="list-style-type: none"> <li>1. Historical Issues Involving Cells               <ol style="list-style-type: none"> <li>a. Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions. (12.8.3)</li> <li>b. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge. (12.8.3)</li> <li>c. Understand that some advancements in science and technology have long-lasting effects on society. (12.8.3)</li> <li>d. Explain how science advances with the introduction of new technology. (12.6.2)</li> </ol> </li> <li>2. Current Issues Involving Cells               <ol style="list-style-type: none"> <li>a. Communicate and defend a scientific argument. (12.2.1)</li> <li>b. Understand that some advancements in science and technology have long-lasting effects on society. (12.8.3)</li> <li>c. Understand that knowledge of basic concepts about scientific and technological challenges should precede active debate. (12.7.6)</li> <li>d. Investigate and understand that social issues and challenges may affect advancements in science and technology. (12.7.6)</li> <li>e. Understand that science and technology are essential social enterprises that indicate what could happen, but not what should happen. (12.7.6)</li> <li>f. Demonstrate ethical scientific practices (e.g., informing research subjects about risks and benefits, human treatment of animals, truthful reporting, public disclosure of work, and peer review). (12.8.1)</li> <li>g. Examine and understand the societal, cultural, and personal beliefs that influence scientists. (12.8.1)</li> </ol> </li> </ol>

**Standards and Example Indicators****12.1.1 Systems, Order, and Organization**

- a. Predict and evaluate how change within a system affects that system.

**12.1.2 Evidence, Models, and Explanations**

- a. Create a physical, mental, or mathematical model to show how objects and processes are connected.
- b. Understand that the way data are displayed affects interpretation.

**12.1.3 Change, Constancy, and Measurement**

Understand that measurement errors may affect results of calculations.

**12.2.1 Scientific Inquiry**

- a. Use technology and mathematics to improve investigations and communications.

**12.3.1 Structure of the Atom**

- a. Investigate and explain the types of nuclear reactions.

**12.3.5 Conservation of Energy and Increase in Disorder**

- a. Understand that the total energy in the universe is constant and can never be destroyed.
- b. Investigate and distinguish between kinetic energy and potential energy
- c. Investigate and describe heat transfer in terms of conduction, convection, and radiation.
- d. Investigate and give examples of how systems tend to become more disorderly over time.

**12.3.6 Interactions of Energy and Matter**

- a. Investigate and understand that all waves possess and transfer energy.
- b. Investigate and illustrate how wavelength and frequency of waves are inversely related.
- c. Investigate and understand that the energy of waves can be changed into other forms of energy, just as other forms of energy can be transformed into wave energy.
- d. Investigate and understand that atoms or molecules can be identified by spectral analysis.

**12.5.1 Understanding the energy in the earth system**

- a. Investigate and distinguish between internal sources of energy (e.g., radioactive decay and gravitational energy) and external sources of energy (e.g., the sun), and explaining how both provide energy to the earth system.
- b. Investigate and explain how the outward transfer of earth's internal heat drives convection in the mantle that propels the plates comprising the earth's surface.
- c. Investigate and explain how global climate is determined by energy transfer from the sun and is influenced by dynamic processes (e.g., cloud formation and the earth's rotation) and static conditions (e.g., the position of mountain ranges and oceans).

**12.5.2 Understanding of Geochemical Cycles**

- a. Investigate and diagram how elements and compounds on earth move among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles.

Concepts and Skills within Standards
<b>A. Conservation of Energy and Increase in Disorder (12.3.5)</b>
<ol style="list-style-type: none"> <li>1. Types of Energy               <ol style="list-style-type: none"> <li>a. Kinetic</li> <li>b. Potential</li> <li>c. Mechanical</li> <li>d. Thermal</li> <li>e. Chemical</li> <li>f. Electromagnetic</li> <li>g. Nuclear                   <ol style="list-style-type: none"> <li>i. Investigate and explain the types of nuclear reactions. (12.3.1)                       <ol style="list-style-type: none"> <li>1) Fission</li> <li>2) Fusion</li> </ol> </li> </ol> </li> </ol> </li> <li>2. Law of Conservation of Energy and Entropy               <ol style="list-style-type: none"> <li>a. Understand that the way data are displayed affects interpretation. (12.1.2)</li> <li>b. Understand that measurement errors may affect results of calculations. (12.1.3)</li> <li>c. Use technology and mathematics to improve investigations and communication. (12.2.1)</li> </ol> </li> <li>3. Transfer of Thermal energy               <ol style="list-style-type: none"> <li>a. Conduction</li> <li>b. Convection</li> <li>c. Radiation</li> </ol> </li> </ol>
<b>B. Interactions of Energy and Matter (12.3.6)</b>
<ol style="list-style-type: none"> <li>1. Characteristics of Waves               <ol style="list-style-type: none"> <li>a. Wavelength</li> <li>b. Frequency</li> <li>c. Amplitude (crest and trough)</li> </ol> </li> <li>2. Types of Waves               <ol style="list-style-type: none"> <li>a. Transverse</li> <li>b. Longitudinal</li> </ol> </li> <li>3. Energy Transfer by Waves               <ol style="list-style-type: none"> <li>a. Earthquakes</li> <li>b. Light and Sound</li> </ol> </li> <li>4. Electromagnetic Spectrum               <ol style="list-style-type: none"> <li>a. Emission</li> <li>b. Absorption</li> </ol> </li> </ol>

Concepts and Skills within Standards
<b>C. Understanding the energy in the earth system (12.5.1)</b>
<ol style="list-style-type: none"> <li>1. Energy in the earth system <ol style="list-style-type: none"> <li>a. Core-mantle-crust structure (review) <ol style="list-style-type: none"> <li>i. Create a physical, mental, or mathematical model to show how objects and processes are connected. (12.1.2)</li> </ol> </li> <li>b. Thermal energy in Earth's interior drives the geosphere <ol style="list-style-type: none"> <li>i. Investigate and diagram how elements and compounds on earth move among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles. (12.5.2) <ol style="list-style-type: none"> <li>1) Evidence for interior heat <ol style="list-style-type: none"> <li>a) Volcanoes</li> <li>b) Deep boreholes: deeper = hotter</li> </ol> </li> <li>2) Origin of heat in the interior <ol style="list-style-type: none"> <li>a) Residual from bombardment (mechanical energy, friction)</li> <li>b) Radioactive decay (25% of heat)</li> </ol> </li> <li>3) Consequences of hot interior <ol style="list-style-type: none"> <li>a) Heat transfer through mantle to crust <ol style="list-style-type: none"> <li>i) Convection (very slow; mantle is solid rock)</li> <li>ii) Partial melting of mantle and crust produces magma: intrusive rocks and volcanoes</li> </ol> </li> <li>b) Plate tectonics: convection mantle moves the plates carrying oceans and continents</li> <li>c) Geological activity (volcanoes, earthquakes) at plate boundaries</li> </ol> </li> </ol> </li> </ol> </li> <li>c. Solar energy (external) drives the atmosphere <ol style="list-style-type: none"> <li>i. Radiant heat (infrared) <ol style="list-style-type: none"> <li>1) Predict and evaluate how change within a system affects that system. (12.1.1)</li> <li>2) Investigate and diagram how elements and compounds on earth move among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles. (12.5.2)</li> </ol> </li> <li>ii. Absorption by land and water</li> <li>iii. Differential heating of surface leads to convection of the atmosphere <ol style="list-style-type: none"> <li>1) Earth's wind (climate) belts</li> <li>2) Coriolis effect</li> <li>3) Influence of water bodies and land masses (rain shadow, differential absorption, wind deflection, etc.)</li> <li>4) Cloud Formation and Precipitation</li> </ol> </li> </ol> </li> </ol> </li> </ol>

**YEAR TWO**

**SENIOR HIGH**

**LABORATORY-BASED**

**NATURAL SCIENCE COURSE**

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# SENIOR HIGH LABORATORY-BASED NATURAL SCIENCE CURRICULUM YEAR TWO

SECTION VII	SCIENTIFIC INQUIRY	YEAR 2
<b>Standards and Example Indicators</b>		
<b>Features of Inquiry</b>		
<b>12.1.2</b>	<b>Evidence, models, and explanation</b> <ul style="list-style-type: none"> <li>a. Create a physical, mental, or mathematical model to show how objects and processes are connected.</li> <li>b. Test the usefulness of the model by comparing its predictions to actual observations.</li> <li>c. Understand that the way data are displayed affects interpretation.</li> <li>d. Evaluate the reasonableness of answers to problems.</li> <li>e. Understand that larger well-chosen samples produce more accurate estimates of the characteristics of the total population.</li> <li>f. Understand that a correlation between two variables does not mean that either one causes the other.</li> </ul>	
<b>12.1.3</b>	<b>Change, constancy, and measurement</b> <ul style="list-style-type: none"> <li>a. Uses of powers of ten to represent large and small numbers.</li> <li>b. Compare data for two groups by using averages and ranges of values.</li> <li>c. Understand that measurement errors may affect results of calculations.</li> <li>d. Describe rate of change by comparing one measured quantity to another measured quantity.</li> <li>e. Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease.</li> </ul>	
<b>12.2.1</b>	<b>Basic Inquiry</b> <ul style="list-style-type: none"> <li>a. Formulate questions and identify concepts that guide scientific investigations.</li> <li>b. Design and conduct scientific investigations.</li> <li>c. Use technology and mathematics to improve investigations and communications.</li> <li>d. Formulate and revise scientific explanations and models using logic and evidence.</li> <li>e. Recognize and analyze alternative explanations and models.</li> <li>f. Communicate and defend a scientific argument.</li> </ul>	
<b>12.6.1</b>	<b>Understanding of Technological Design</b> <ul style="list-style-type: none"> <li>a. Propose designs and choose between alternative solutions of a problem.</li> <li>b. Implement the selected solution.</li> <li>c. Evaluate the solution and its consequences.</li> <li>d. Communicate the problem, process, and solution.</li> </ul>	
<b>12.8.1</b>	<b>Understanding of Science as a Human Endeavor</b> <ul style="list-style-type: none"> <li>a. Recognize science as one way of answering questions and explaining the natural world.</li> </ul>	
<b>12.8.2</b>	<b>Understanding the Nature of Scientific Knowledge</b> <ul style="list-style-type: none"> <li>a. Create scientific explanations consistent with experimental and observational evidence; make accurate predictions; strive to be logical; respect the rules of evidence; accept criticism; report methods and procedures; and make knowledge public.</li> </ul>	

Concepts and Skills within Standards
<b>A. Features of Inquiry (12.2.1)</b>
<ol style="list-style-type: none"> <li>1. Engaging in Scientifically Oriented Questions               <ol style="list-style-type: none"> <li>a. Formulate questions and identify concepts that guide scientific investigations. (12.2.1)                   <ol style="list-style-type: none"> <li>i. Questioning</li> <li>ii. Predicting</li> <li>iii. Forming Hypotheses</li> </ol> </li> </ol> </li> <li>2. Responding to Questions using Evidence               <ol style="list-style-type: none"> <li>a. Design and conduct scientific investigations. (12.2.1)</li> <li>b. Propose designs and choose between alternative solutions of a problem. (12.6.1)</li> <li>c. Implement the selected solution. (12.6.1)                   <ol style="list-style-type: none"> <li>i. Identifying Variables</li> <li>ii. Designing Experiments                       <ol style="list-style-type: none"> <li>1) Understand that larger well-chosen samples produce more accurate estimates of the characteristics of the total population. (12.1.2)</li> </ol> </li> <li>iii. Making Qualitative and Quantitative Observations                       <ol style="list-style-type: none"> <li>1) Understand that measurement errors may affect results of calculations. (12.1.3)</li> </ol> </li> <li>iv. Recording Data</li> </ol> </li> </ol> </li> <li>3. Formulating Explanations from Evidence               <ol style="list-style-type: none"> <li>a. Use technology and mathematics to improve investigations and communications. (12.2.1)</li> <li>b. Evaluate the solution and its consequences. (12.6.1)                   <ol style="list-style-type: none"> <li>i. Organizing Data                       <ol style="list-style-type: none"> <li>1) Understand that the way data are displayed affects interpretation. (12.1.2)                           <ol style="list-style-type: none"> <li>a) Graphs</li> <li>b) Tables</li> <li>c) Calculations                               <ol style="list-style-type: none"> <li>i) Uses of powers of ten to represent large and small numbers. (12.1.3)</li> </ol> </li> <li>d) Schematics</li> </ol> </li> <li>ii. Manipulating Data</li> <li>iii. Interpreting Evidence                       <ol style="list-style-type: none"> <li>1) Evaluate the reasonableness of answers to problems. (12.1.2)</li> <li>2) Understand that a correlation between two variables does not mean that either one causes the other. (12.1.2)</li> <li>3) Compare data for two groups by using averages and ranges of values. (12.1.3)</li> <li>4) Describe rate of change by comparing one measured quantity to another measured quantity. (12.1.3)</li> <li>5) Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease. (12.1.3)</li> </ol> </li> <li>iv. Creating Models                       <ol style="list-style-type: none"> <li>1) Create a physical, mental, or mathematical model to show how objects and processes are connected (12.1.2)</li> </ol> </li> </ol> </li> </ol> </li> <li>4. Connecting Explanations to Scientific Knowledge               <ol style="list-style-type: none"> <li>a. Formulate and revise scientific explanations and models using logic and evidence. (12.2.1)</li> <li>b. Evaluate the solution and its consequences (12.6.1).                   <ol style="list-style-type: none"> <li>i. Inferring</li> <li>ii. Connecting to Existing Models                       <ol style="list-style-type: none"> <li>1) Test the usefulness of the model by comparing its predictions to actual observations. (12.1.2)</li> </ol> </li> <li>iii. Defending Findings                       <ol style="list-style-type: none"> <li>1) Evaluate the reasonableness of answers to problems. (12.1.2)</li> </ol> </li> </ol> </li> </ol> </li> </ol> </li></ol>

Concepts and Skills within Standards
5. Communicating and Justifying Explanations <ul style="list-style-type: none"><li>a. Use technology and mathematics to improve investigations and communications. (12.2.1)</li><li>b. Formulate and revise scientific explanations and models using logic and evidence. (12.2.1)</li><li>c. Recognize and analyze alternative explanations and models. (12.2.1)</li><li>d. Communicate and defend a scientific argument. (12.2.1)</li><li>e. Communicate the problem, process, and solution. (12.6.1)<ul style="list-style-type: none"><li>i. Communicating Explanations</li><li>ii. Defending Explanations</li><li>iii. Publishing</li><li>iv. Determining Applications</li><li>v. Asking Further Questions</li></ul></li></ul>

**Standards and Example Indicators****Heredity****12.1.2 Evidence, models, and explanation**

- a. Create a physical, mental, or mathematical model to show how objects and processes are connected.
- b. Evaluate the reasonableness of answers to problems.

**12.1.4 Understanding of Form and Function**

- a. Explain function by referring to form and explain form by referring to function.

**12.2.1 Basic Inquiry (discuss on introductory page)**

- a. Formulate and revise scientific explanations and models using logic and evidence.

**12.4.2 Molecular Basis of Heredity**

- a. Investigate and describe how DNA carries the genetic code.
- b. Investigate and understand that genetic variation occurs when genetic information is transmitted during sexual reproduction.
- c. Investigate and explain how some mutations could help, harm, or have no effect on individual organisms.
- d. Investigate and explain how mutations in sex cells, but not in body cells, could be passed on to offspring.

**12.6.2 Interactions of Science & Technology**

- a. Explain how science advances with the introduction of new technology.
- b. Understand creativity, imagination, and a good knowledge base are all needed to advance the work of science and engineering.
- c. Contrast the reasons for the pursuit of science and the pursuit of technology.
- d. Contrast the reporting of scientific knowledge and the reporting of technical knowledge.

**12.7.1 Personal & Community Health**

- a. Investigate and explain how genetic traits affect a person's health.

**12.7.6 Technology in local, national, & global challenges**

- a. Understand that knowledge of basic concepts about scientific and technological challenges should precede active debate.
- b. Investigate and understand that social issues and challenges may affect advancements in science and technology.
- c. Understand that science and technology are essential social enterprises that indicate what could happen, but not what should happen.

**12.8.3 Historical Contributors**

- a. Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions.
- b. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge.
- c. Understand that some advancements in science and technology have long-lasting effects on society.

Concepts and Skills within Standards
<b>A. Historical Contributions to Molecular Genetics</b> <ul style="list-style-type: none"> <li>Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge. (12.8.3)</li> <li>Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions. (12.8.3)</li> </ul>
<b>B. Structure of Nucleic Acid (12.4.2)</b> <ul style="list-style-type: none"> <li>Investigate and describe how DNA carries the genetic code.</li> <li>Explain function by referring to form and explain form by referring to function. (12.1.4)</li> <li>Creativity, imagination, and a good knowledge base are all needed to advance the work of science and engineering. (12.6.2)</li> <li>Understandings have advanced with the introduction of new technology. (12.6.2)</li> <li>Contrast the reasons for the pursuit of science and the pursuit of technology. (12.6.2)</li> <li>Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions. (12.8.3)</li> </ul>
<ol style="list-style-type: none"> <li>DNA             <ol style="list-style-type: none"> <li>Create a physical, mental, or mathematical model to show how objects and processes are connected (12.1.2).                 <ol style="list-style-type: none"> <li>Structure</li> <li>Function</li> </ol> </li> </ol> </li> <li>RNA             <ol style="list-style-type: none"> <li>Structure</li> <li>Function</li> </ol> </li> <li>Protein Synthesis             <ol style="list-style-type: none"> <li>Transcription</li> <li>Translation</li> </ol> </li> </ol>
<b>C. Meiosis (12.4.2)</b> <ul style="list-style-type: none"> <li>Investigate and understand that genetic variation occurs when genetic information is transmitted during sexual reproduction.</li> </ul>
<ol style="list-style-type: none"> <li>Natural Genetic Variation             <ol style="list-style-type: none"> <li>Crossing over</li> <li>Independent assortment</li> <li>Random fertilization</li> </ol> </li> </ol>
<b>D. Mutations (12.4.2)</b> <ul style="list-style-type: none"> <li>Investigate and explain how some mutations could help, harm, or have no effect on individual organisms.</li> <li>Investigate and explain how mutations in sex cells, but not in body cells, could be passed on to offspring.</li> </ul>
<ol style="list-style-type: none"> <li>Types of Mutations</li> <li>Effects of mutations             <ol style="list-style-type: none"> <li>Helpful</li> <li>Harmful</li> <li>No effect</li> </ol> </li> <li>Transmission of mutations</li> <li>Effects on Personal Health             <ol style="list-style-type: none"> <li>Investigate and explain how genetic traits affect a person's health (12.7.1)</li> </ol> </li> </ol>
<b>E. Social Issues Related to Molecular Genetics</b> <ul style="list-style-type: none"> <li>Evaluate the reasonableness of answers to problems (12.1.2).</li> <li>Understand that knowledge of basic concepts about scientific and technological challenges should precede active debate (12.7.6)</li> <li>Investigate and understand that social issues and challenges may affect advancements in science and technology. (12.7.6)</li> <li>Understand that science and technology are essential social enterprises that indicate what could happen, but not what should happen (12.7.6)</li> <li>Understand that some advancements in science and technology have long-lasting effects on society (12.8.3).</li> </ul>

Standards and Example Indicators	
Evolution and Earth's History	
<b>12.1.2 Evidence, models, and explanation</b>	a. Evaluate the reasonableness of answers to problems.
<b>12.1.1 Develop an understanding of systems, order, and organization</b>	a. Predict and evaluate how change within a system affects that system. b. Design solutions to problems identified within a system.
<b>12.1.5 Change over a Period of Time</b>	a. Identify the series of changes that occur in objects, organisms, and natural and human designed systems.
<b>12.2.1 Basic Inquiry (discuss on introductory page)</b>	a. Recognize and analyze alternative explanations and models. b. Communicate and defend a scientific argument.
<b>12.4.3 Biological Evolution</b>	a. Understand that the concept of biological evolution is a theory which explains the consequence of the interactions of: (1) the potential for a species to increase its numbers; (2) the genetic variability of offspring due to mutation and recombination of genes; (3) a finite supply of the resources of life; and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring. b. Investigate and use the theory of biological evolution to explain diversity of life. c. Investigate whether natural selection provides a scientific explanation of the fossil record and the molecular similarities among the diverse species of living organisms. d. Investigate and use biological classifications based on similarities.
<b>12.4.6 Behavior of Organisms</b>	a. Investigate and explain how the behavioral patterns of organisms have evolved through natural selection.
<b>12.5.3 Origin of the Earth System</b>	a. Contrast the early Earth with the planet we live on today. b. Investigate and estimate geologic time by observing rock sequences and using fossils to correlate the sequences at various locations. c. Predict when rocks were formed by using known decay rates. d. Investigate and relate how the interactions among the solid Earth, oceans, atmosphere, and organisms affect the ongoing evolution of the earth.
<b>12.6.2 Interactions of Science &amp; Technology</b>	a. Explain how science advances with the introduction of new technology.
<b>12.7.6 Technology in local, national, &amp; global challenges</b>	a. Understand that knowledge of basic concepts about scientific and technological challenges should precede active debate. b. Investigate and understand that social issues and challenges may affect advancements in science and technology.
<b>12.8.3 Historical Contributors</b>	a. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge. b. Understand that some advancements in science and technology have long-lasting effects on society (i.e. mechanisms for evolution and changes in the gene pool).

**Section IX/Evolution and Earth's History/Year 2 (con't)**

<b>Concepts and Skills within Standards</b>
<p><b>A. Origin of the earth system (12.5.3)</b></p> <ul style="list-style-type: none"> <li>• Contrast the early earth with the planet we live on today.</li> <li>• Investigate and estimate geologic time by observing rock sequences and using fossils to correlate the sequences at various locations.</li> <li>• Predict when rocks were formed by using known decay rates.</li> <li>• Investigate and relate how the interactions among the solid earth, oceans, atmosphere, and organisms affect the ongoing evolution of the earth.</li> </ul>
<ol style="list-style-type: none"> <li>1. Earth Formation</li> <li>2. Pangaea and older continent-ocean configurations               <ol style="list-style-type: none"> <li>a. Explanations for plate movement</li> <li>b. Evidence for plate movement</li> <li>c. Plate tectonics theory</li> </ol> </li> <li>3. The rock record and Earth history               <ol style="list-style-type: none"> <li>a. Evaluate the reasonableness of answers to problems. (12.1.2)                   <ol style="list-style-type: none"> <li>i. Geologic time scale</li> <li>ii. Relative dating</li> <li>iii. Numerical dating</li> <li>iv. Interactions among earth systems in geologic time</li> </ol> </li> </ol> </li> </ol>
<p><b>B. Biological Evolution (12.4.3)</b></p> <ul style="list-style-type: none"> <li>• Understand that the concept of biological evolution is a theory which explains the consequence of the interactions of: (1) the potential for a species to increase its numbers; (2) the genetic variability of offspring due to mutation and recombination of genes; (3) a finite supply of the resources of life; and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.</li> <li>• Investigate and use the theory of biological evolution to explain diversity of life.</li> <li>• Investigate whether natural selection provides a scientific explanation of the fossil record and the molecular similarities among the diverse species of living organisms.</li> <li>• Investigate and use biological classifications based on similarities.</li> </ul>
<ol style="list-style-type: none"> <li>1. Theory of Biological Evolution               <ol style="list-style-type: none"> <li>a. Explains the consequences of the interaction between                   <ol style="list-style-type: none"> <li>i. Potential for species to increase numbers</li> <li>ii. Genetic Variability</li> <li>iii. Finite Supply of Resources</li> <li>iv. Selection of the Fittest</li> </ol> </li> <li>b. Explains the diversity of life                   <ol style="list-style-type: none"> <li>i. Predict and evaluate how change within a system affects that system. (12.1.1)</li> <li>ii. Design solutions to problems identified within a system. (12.1.1)</li> <li>iii. Identify the series of changes that occur in objects, organisms, and natural and human designed systems. (12.1.5)</li> </ol> </li> </ol> </li> <li>2. Natural Selection               <ol style="list-style-type: none"> <li>a. Provides an explanation of fossil records</li> <li>b. Provides an explanation of molecular similarities in organisms                   <ol style="list-style-type: none"> <li>i. Investigate and explain how the behavioral patterns of organisms have evolved. (12.4.6)</li> <li>ii. Explain how understandings have advanced with the introduction of new technology. (12.6.2)</li> </ol> </li> </ol> </li> <li>3. Biological Classification               <ol style="list-style-type: none"> <li>a. Anatomical Relationships</li> <li>b. Molecular Relationships</li> </ol> </li> </ol>

**Section IX/Evolution and Earth's History/Year 2 (*con't*)**

**Concepts and Skills within Standards**

4. Evolution and Social Issues

- a. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge. (12.8.3)
- b. Understand that some advancement in science and technology have long-lasting effects on society. (12.8.3)
- c. Understand that knowledge of basic concepts about scientific and technological challenges should precede active debate. (12.7.6)
- d. Investigate and understand that social issues and challenges may affect advancements in science and technology. (12.7.6)



Standards and Example Indicators	
Environmental Systems	
<b>12.1.2 Evidence, models, and explanation</b>	<ul style="list-style-type: none"> <li>a. Understand that the way data are displayed affects interpretation.</li> <li>b. Understand that larger well-chosen samples produce more accurate estimates of the characteristics of the total population.</li> <li>c. Understand that a correlation between two variables does not mean that either one causes the other.</li> </ul>
<b>12.1.1 Develop an understanding of systems, order, and organization</b>	<ul style="list-style-type: none"> <li>a. Predict and evaluate how change within a system affects that system.</li> <li>b. Design solutions to problems identified within a system.</li> </ul>
<b>12.1.3 Change, Constancy, and Measurement</b>	<ul style="list-style-type: none"> <li>a. Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease.</li> </ul>
<b>12.1.5 Change over a Period of Time</b>	<ul style="list-style-type: none"> <li>a. Identify the series of changes that occur in objects, organisms, and natural and human designed systems.</li> <li>b. Explain how a system at equilibrium is affected by change.</li> </ul>
<b>12.2.1 Basic Inquiry (discuss on introductory page)</b>	<ul style="list-style-type: none"> <li>a. Formulate questions and identify concepts that guide scientific investigations.</li> <li>b. Design and conduct scientific investigations.</li> </ul>
<b>12.4.4 Interdependence of Organisms</b>	<ul style="list-style-type: none"> <li>a. Investigate and understand that atoms and molecules cycles among living and nonliving components of the biosphere.</li> <li>b. Investigate and describe the flow of energy through ecosystems, in one direction, from producers to herbivores to carnivores and decomposers.</li> <li>c. Investigate and cite examples of organisms cooperating and competing in ecosystems.</li> <li>d. Investigate and understand that interactions among organisms are affected by the conflict between an organism's capacity to produce infinite populations and the finite amount of resources.</li> <li>e. Investigate and describe how humans modify the ecosystem as a result of population growth, technology, and consumption.</li> </ul>
<b>12.4.5 Matter, Energy, and Organization</b>	<ul style="list-style-type: none"> <li>a. Investigate and describe how distribution and abundance of different organisms in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials.</li> <li>b. Investigate and understand that living systems require a constant input of energy to maintain their chemical and physical organization.</li> </ul>
<b>12.5.2 Understanding of Geochemical Cycles</b>	<ul style="list-style-type: none"> <li>a. Investigate and describe how elements and compounds on earth move among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles. (Water, Rock, Carbon, Nitrogen)</li> </ul>
<b>12.7.1 Personal and Community Health</b>	<ul style="list-style-type: none"> <li>a. Investigate and describe the effect of nutritional balance on growth, development, and personal well-being.</li> <li>b. Investigate and explain how diseases are prevented, controlled, and cured.</li> <li>c. Investigate and analyze risks and benefits in making decisions about personal and community health.</li> </ul>

Standards and Example Indicators	
<b>12.7.2 Effects of Population Change</b>	<ul style="list-style-type: none"> <li>a. Investigate and identify causes of population growth or decline.</li> <li>b. Investigate and explain how various factors influence birth rates and death rates.</li> <li>c. Investigate and predict how population change may impact resource use and environments.</li> </ul>
<b>12.7.3 Natural Resources</b>	<ul style="list-style-type: none"> <li>a. Investigate and explain how human populations use environmental resources to maintain and improve their existence.</li> <li>b. Investigate and understand that the Earth has renewable and finite resources.</li> <li>c. Investigate and understand the limitations of natural systems to recycle resources.</li> </ul>
<b>12.7.4 Environmental Quality</b>	<ul style="list-style-type: none"> <li>a. Investigate and describe how the positive and negative consequences of human intervention or nonintervention impact the ecosystem.</li> <li>b. Investigate and explain factors which may influence environmental quality.</li> </ul>
<b>12.7.5 Natural and Human induced Hazards</b>	<ul style="list-style-type: none"> <li>a. Investigate and describe how human activities increase or reduce the potential for hazards.</li> <li>b. Investigate and distinguish between slowly and rapidly occurring natural hazards and their impact on the environment.</li> </ul>
<b>12.7.6 Role of science and technology in local, national, and global challenges</b>	<ul style="list-style-type: none"> <li>a. Understand that knowledge of basic concepts about scientific and technological challenges should precede active debate.</li> <li>b. Investigate and understand that social issues and challenges may affect advancements in science and technology.</li> <li>c. Understand that science and technology are essential social enterprises that indicate what could happen, but not what should happen.</li> </ul>
<b>12.8.3 Historical Contributors</b>	<ul style="list-style-type: none"> <li>a. Understand that some advancements in science and technology have long-lasting effects on society.</li> </ul>

Concepts and Skills within Standards	
<b>A. Interdependence of Organisms (12.4.4)</b>	<ul style="list-style-type: none"> <li>• Investigate and understand that atoms and molecules cycles among living and nonliving components of the biosphere.</li> <li>• Investigate and describe the flow of energy through ecosystems, in one direction, from producers to herbivores to carnivores and decomposers.</li> <li>• Investigate and cite examples of organisms cooperating and competing in ecosystems.</li> <li>• Investigate and understand that interactions among organisms are affected by the conflict between an organism's capacity to produce infinite populations and the finite amount of resources.</li> <li>• Investigate and describe how humans modify the ecosystem as a result of population growth, technology, and consumption.</li> </ul>
<b>1. Population Biology</b>	<ul style="list-style-type: none"> <li>a. Effects of Population Change               <ul style="list-style-type: none"> <li>i. Impact of resource availability on cooperation and competition among population.                   <ul style="list-style-type: none"> <li>1) Investigate and identify causes of population growth or decline. (12.7.2)</li> <li>2) Investigate and explain factors that influence birth rates and death rates. (12.7.2)</li> <li>3) Investigate and predict how population change may impacts resource use and environments. (12.7.2)</li> <li>4) Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease. (12.1.3)</li> </ul> </li> </ul> </li> </ul>

Concepts and Skills within Standards
<ul style="list-style-type: none"> <li>b. Carrying Capacity               <ul style="list-style-type: none"> <li>i. Investigate and explain how human populations use environmental resources to maintain and improve existence. (12.7.3)</li> <li>ii. Investigate and understand that Earth has renewable and finite resources. (12.7.3)</li> <li>iii. Investigate and understand the limitations of natural systems to recycle resources. (12.7.3)</li> <li>iv. Investigate and describe the effect of nutritional balance on growth, development, and personal well-being. (12.7.1)</li> <li>v. Explain how a system a equilibrium is affected by change. (12.1.5)</li> </ul> </li> <li>2. Energy Flow in Biological Systems               <ul style="list-style-type: none"> <li>a. Investigate and understand that living systems require a constant input of energy to maintain their chemical and physical organization. (12.4.5)                   <ul style="list-style-type: none"> <li>i. Energy Transfer</li> <li>ii. Energy Pyramid</li> </ul> </li> </ul> </li> </ul>
<p><b>B. Understanding of Geochemical Cycles (12.5.2)</b></p> <ul style="list-style-type: none"> <li>• Investigate and describe how elements and compounds on earth move among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles. (Water, Rock, Carbon, Nitrogen)</li> </ul>
<ul style="list-style-type: none"> <li>1. Reinforce cycle concept</li> <li>2. Examples of geochemical cycles               <ul style="list-style-type: none"> <li>a. Water</li> <li>b. Rock</li> <li>c. Carbon</li> <li>d. Nitrogen</li> </ul> </li> </ul>
<p><b>C. Science as a Social Perspective (12.7.6)</b></p> <ul style="list-style-type: none"> <li>• Understand that knowledge of basic concepts about scientific and technological challenges should precede active debate.</li> <li>• Investigate and understand that social issues and challenges may affect advancements in science and technology.</li> <li>• Understand that science and technology are essential social enterprises that indicate what could happen, but not what should happen.</li> </ul>
<ul style="list-style-type: none"> <li>1. Environmental Quality               <ul style="list-style-type: none"> <li>a. Investigate and describe how consequences of human intervention or nonintervention impacting the ecosystem. (12.7.4)</li> <li>b. Investigate and describe factors influencing environmental quality. (12.7.4)</li> <li>c. Identify the series of changes that occur in objects, organisms, and natural and human designed systems. (12.1.5)</li> <li>d. Predict and evaluate how change within a system affects that system. (12.1.1)</li> <li>e. Design solutions to problems identified within a system. (12.1.1)</li> </ul> </li> <li>2. Natural &amp; Human induced Hazards and Disease               <ul style="list-style-type: none"> <li>a. Investigate and describe how human activities increase or reduce the potential for hazards. (12.7.5)</li> <li>b. Investigate and distinguish between slowly and rapidly occurring natural hazards and their impact on the environment. (12.7.5)</li> <li>c. Investigate and explain how diseases are prevented, controlled, and cured. (12.7.1)</li> <li>d. Investigate and analyze risks and benefits in making decisions about personal and community health. (12.7.1)</li> </ul> </li> <li>3. Science and Technology in Local, National, and Global Challenges               <ul style="list-style-type: none"> <li>a. Understand that the way data are displayed affects interpretation. (12.1.2)</li> <li>b. Understand that larger well-chosen samples produce more accurate estimates of the characteristics of the total population. (12.1.2)</li> <li>c. Understand that a correlation between two variables does not mean that either one causes the other. (12.1.2)</li> </ul> </li> </ul>

SECTION XI	FORCES AND MOTIONS	YEAR 2
Standards and Example Indicators		
Forces and Motion		
<b>12.1.2 Evidence, models, and explanation</b>		
a. Create a physical, mental, or mathematical model to show how objects and processes are connected.		
b. Test the usefulness of the model by comparing its predictions to actual observations.		
c. Understand that the way data are displayed affects interpretation.		
<b>12.1.3 Change, Constancy, and Measurement</b>		
a. Use powers of ten to represent large and small numbers.		
b. Compare data for two groups by using averages and ranges of values.		
c. Understand that measurement errors may affect results of calculations.		
d. Describe rate of change by comparing one measured quantity to another measured quantity.		
e. Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease.		
<b>12.1.5 Change over a Period of Time</b>		
a. Explain how a system at equilibrium is affected by change.		
<b>12.2.1 Basic Inquiry (discuss on introductory page)</b>		
a. Design and conduct scientific investigations.		
b. Use technology and mathematics to improve investigations and communications.		
<b>12.3.4 Motions and Forces</b>		
a. Investigate and understand the effort of forces on the motion of objects.		
b. Investigate and understand gravity as an attractive force that each mass exerts on any other mass.		
c. Investigate and understand electrical force as a force that exists between any two charged objects.		
d. Investigate and describe an electric field, a magnetic field, and the interaction between them.		
<b>12.3.6 Interactions of Energy and Matter</b>		
a. Understand that electromagnetic waves result when a charged object accelerates.		
b. Investigate and describe how the composition and temperature of a material affects electron flow.		
<b>12.6.2 Interactions of Science and Technology</b>		
a. Explain how science advances with the introduction of new technology.		
b. Understand creativity, imagination, and a good knowledge base are all needed to advance the work of science and engineering.		
c. Contrast the reporting of scientific knowledge and the reporting of technical knowledge.		
<b>12.8.3 Historical Contributors</b>		
a. Investigate and describe the contributions of diverse cultures to scientific knowledge and technological inventions.		
b. Understand that changes in scientific knowledge evolve over time and almost always build on earlier knowledge.		
c. Understand that some advancements in science and technology have long-lasting effects on society.		

<b>Concepts and Skills within Standards</b>	
<b>A. Newton's Laws (12.3.4)</b>	
<ul style="list-style-type: none"> <li>Investigate and understand the effort of force on the motion of objects.</li> </ul>	
1. Newton's 1 <sup>st</sup> Law (Law of Inertia) <ol style="list-style-type: none"> <li>Objects in motion</li> <li>Objects at rest</li> </ol>	
2. Newton's 2 <sup>nd</sup> Law ( $F = ma$ ) <ol style="list-style-type: none"> <li>Relation of mass and acceleration               <ol style="list-style-type: none"> <li>Create a physical, mental, or mathematical model to show how objects and processes are connected. (12.1.2)</li> <li>Understand that the way data are displayed affects interpretation. (12.1.2)</li> <li>Describe rate of change by comparing one measured quantity to another measured quantity. (12.1.3)</li> <li>Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease. (12.1.3)</li> <li>Explain how a system a equilibrium is affected by change. (12.1.5)</li> </ol> </li> </ol>	
3. Newton's 3 <sup>rd</sup> Law (action/reaction) <ol style="list-style-type: none"> <li>Forces occur in pairs               <ol style="list-style-type: none"> <li>Test the usefulness of the model by comparing its predictions to actual observations. (12.1.2)</li> <li>Understand that measurement errors may affect results of calculations. (12.1.3)</li> </ol> </li> </ol>	
<b>B. Gravity (12.3.4)</b>	
<ul style="list-style-type: none"> <li>Investigate and understand gravity as an attractive force that each mass exerts on any other mass.</li> </ul>	
1. Distinction between weight and mass 2. Force of attraction <ol style="list-style-type: none"> <li>Use powers of ten to represent large and small numbers. (12.1.3)</li> </ol>	
<b>C. Electric Force (12.3.4)</b>	
<ul style="list-style-type: none"> <li>Investigate and understand electrical force as a force that exists between any two charged objects.</li> </ul>	
1. May be attractive or repulsive 2. Holds atoms together (electrons– and nucleus+) 3. Compare and contrast with gravity <ol style="list-style-type: none"> <li>Compare data for two groups by using averages and ranges of values. (12.1.3)</li> </ol>	
<b>D. Fields (12.3.4)</b>	
<ul style="list-style-type: none"> <li>Investigate and describe an electric field, a magnetic field, and the interaction between them.</li> <li>Understand creativity, imagination, and a good knowledge base are all needed to advance the work of science and engineering. (12.6.2)</li> </ul>	
1. Electric field 2. Magnetic field 3. Interactions of fields	
<b>E. Electromagnetic Waves</b>	
1. Generation of Electromagnetic Waves <ol style="list-style-type: none"> <li>Understand that electromagnetic waves result when a charged object accelerates. (12.3.6)</li> </ol>	
2. Electrical resistance <ol style="list-style-type: none"> <li>Investigate and describe how the composition and temperature of a material affects electron flow. (12.3.6)</li> <li>Explain how science advances with the introduction of new technology. (12.6.2)</li> </ol>	